Dimming Ballasts

Appliance Efficiency Rulemaking
California Energy Commission

May 6, 2014

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Agenda

- Pre-rulemaking
- Background
- Efficiency Opportunities
- Regulatory Approaches
- Staff Proposal
- Cost and Savings Analysis
- Next Steps
- Discussion and Comments

Pre-rulemaking

Order Instituting Rulemaking (3/14/12)

Commission identified a variety of appliances with the potential to save energy and/or water for appliance efficiency measures.

Invitation to Participate (3/25/13)

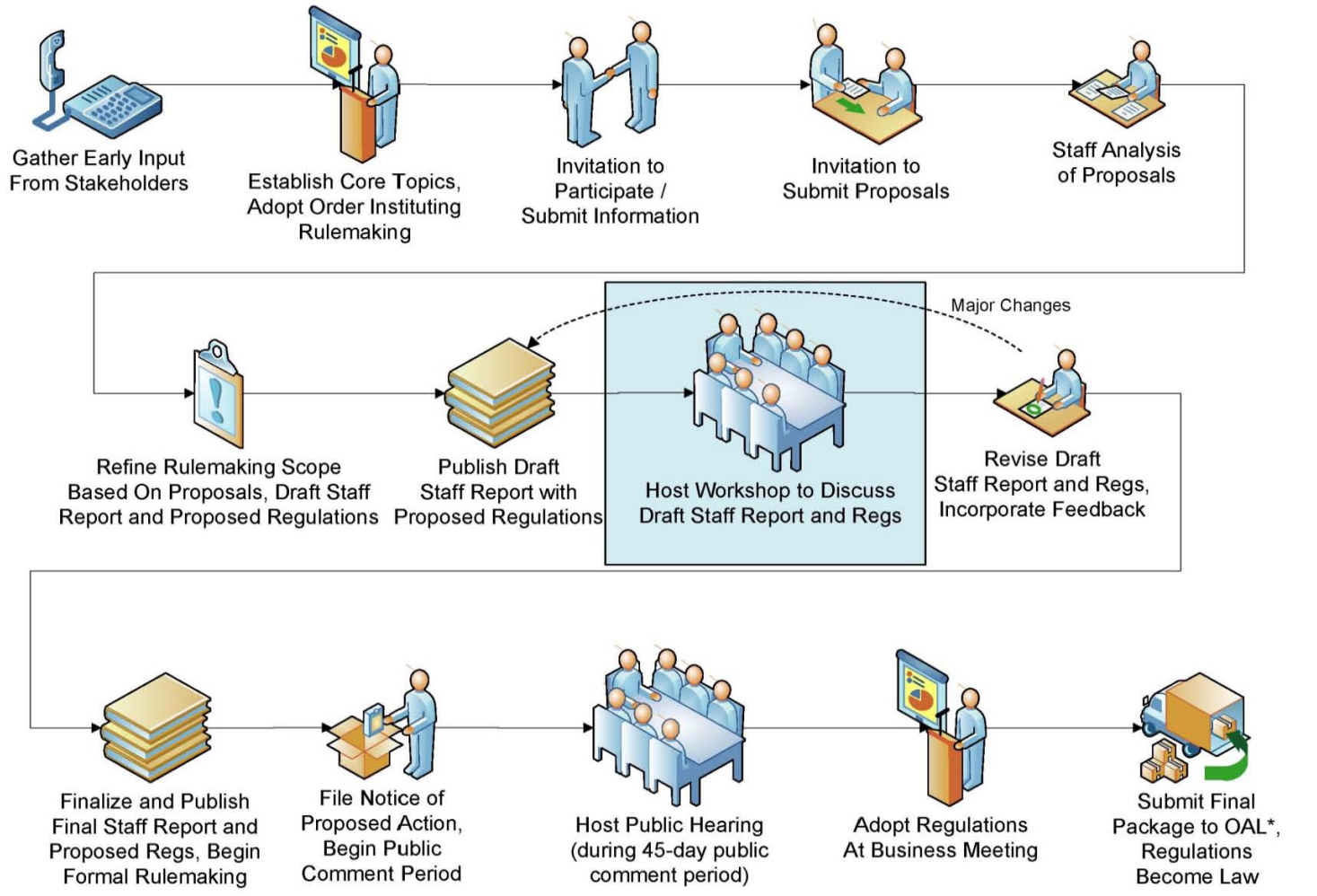
Opportunity for interested parties to inform the Commission about the product, market, and industry characteristics of the appliances identified in the OIR.

Invitation to Submit Proposals (6/13/13)

Opportunity for interested parties to submit proposals for standards, test procedures, labeling requirements, and other measures to improve efficiency.

Appliance Energy Efficiency Rulemaking Process

5/2/2013



*Office of Administrative Law

Background - Description of Dimming Ballasts

Dimming ballasts are designed to dim fluorescent lamps to less than full output.

Products that are not capable of dimming to 50% or less are already covered by the US DOE.

Ballasts can dim continuously, in discrete steps, or by switching a certain number of connected lamps off.

To set a dimming level a ballast can be controlled by several industry standardized dimming signals including: low voltage DC, phase chopping, and digital communications.

Background - A Changing Dimming Ballast Landscape

Historically dimming ballasts have represented a small fraction of all ballast shipments.

California's Title 24 building efficiency regulations will cause a market shift towards a greater number of dimming ballasts.

Dimming ballasts represent an energy saving opportunity through light "tuning," daylight adjustments, and other dimming opportunities where full output light would have been used.

Dimming ballasts can also cause an increase in energy consumption at higher outputs because of lower ballast efficiency.

Background - Title 24 Regulations

Figure 5: Table 130.1-A of Title 24

Luminaire Type	Minimum Required Control Steps (percent of full rated power)				Uniform level of illuminance shall be achieved by:
Linear fluorescent and U-bent fluorescent > 13 watts	Minimum one step in each range:				Stepped dimming; or continuous dimming; or switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire, illuminating the same area and in the same manner
	20-40%	50-70%	80-85%	100%	

Source: Cal. Code Regs., tit. 24, pt. 6, § 130.1 and Table 130.1-A

Background - Efficiency Testing

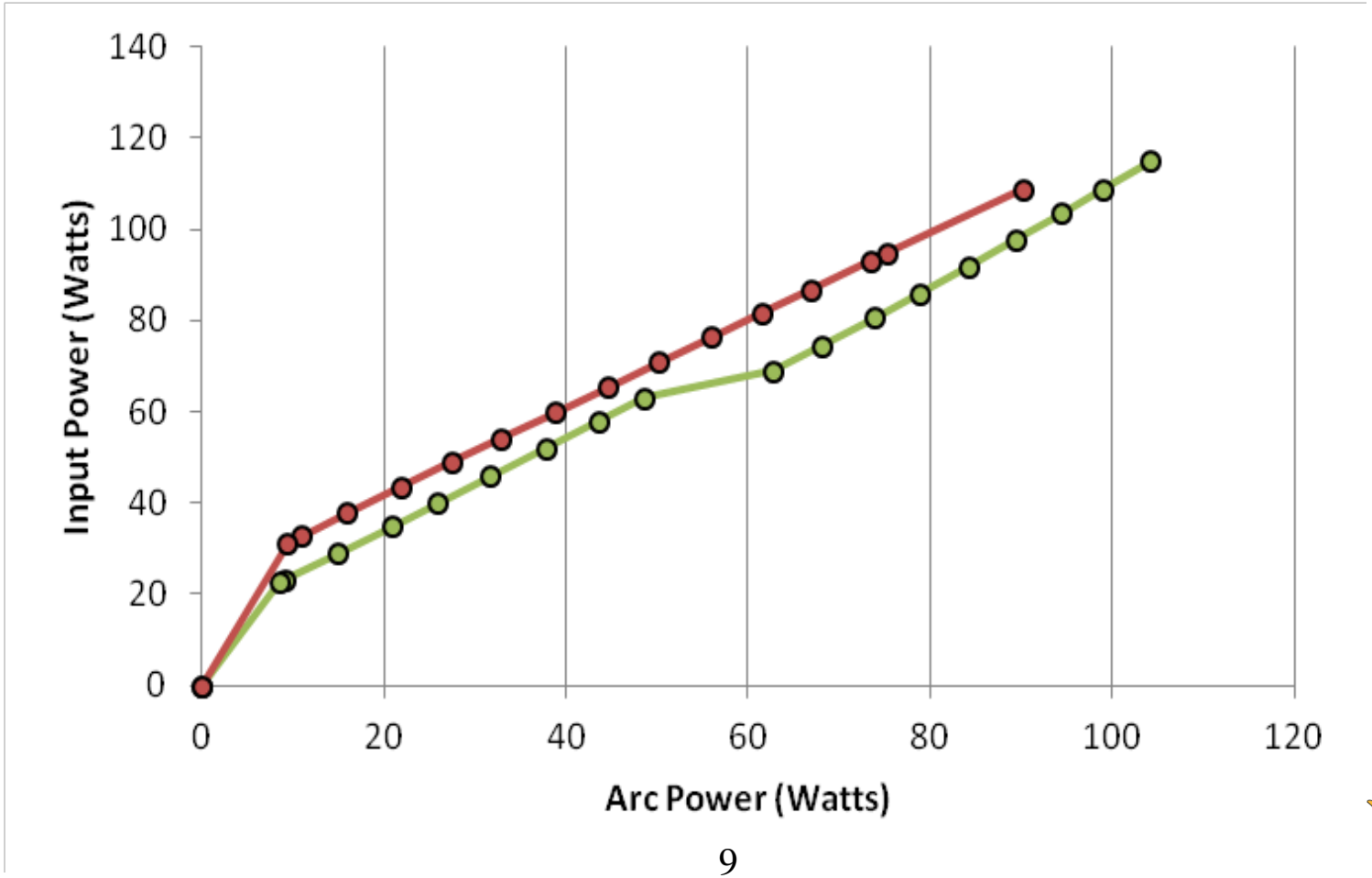
The IOUs shared test data for 32 continuous dimming ballasts

Tests were conducted across the dimming range, at 5% increments of input power

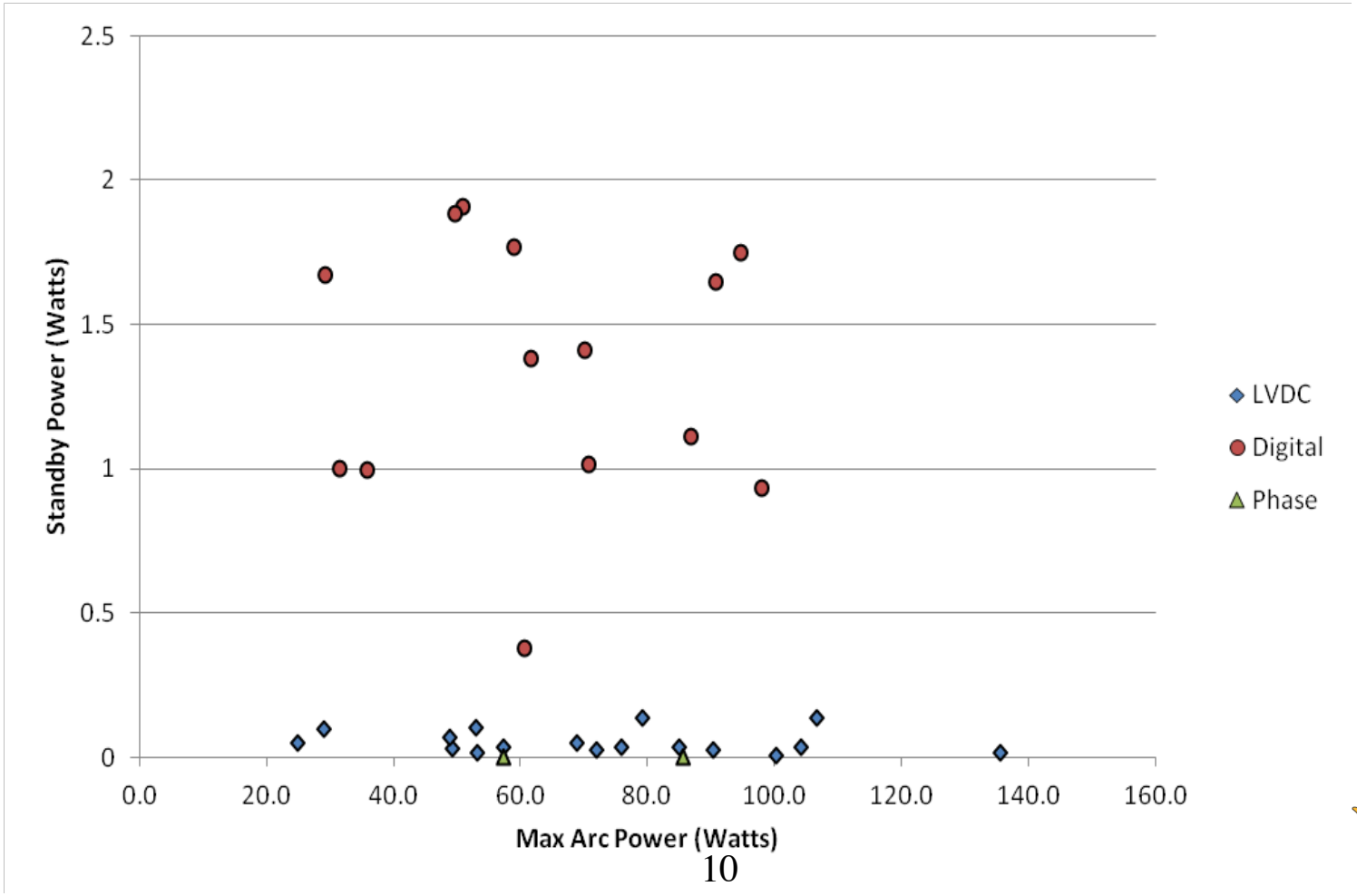
Data revealed significant efficiency variation and opportunities

Dimming ballasts can be as much as 10% less efficient than comparable fixed-output are required to be by DOE

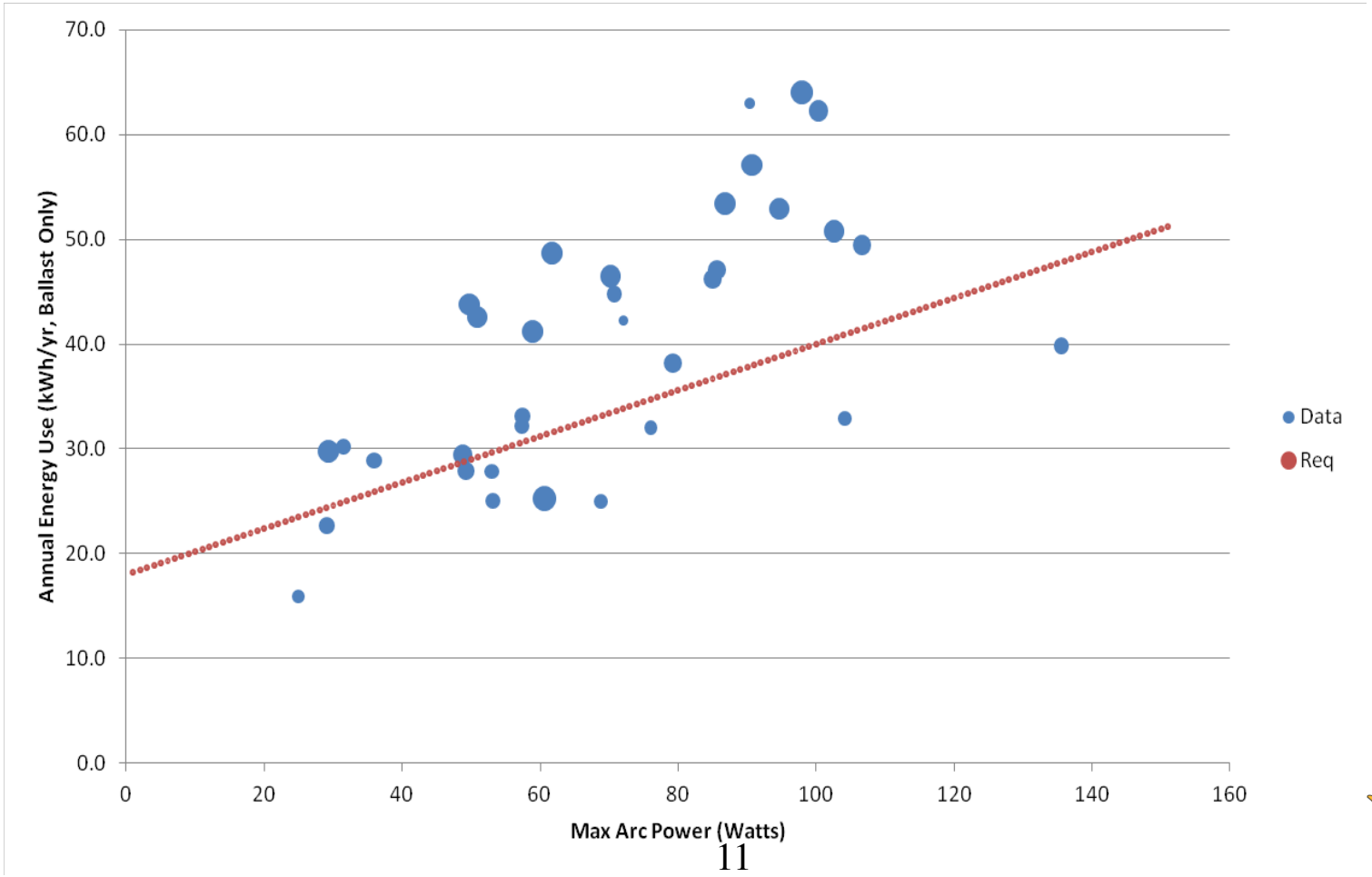
Efficiency Opportunity



Standby Opportunity



Energy Use and Price



Summary of Opportunities

Improved BLE

- Better components

Cathode Cut-out

Low Standby power

-Sleep modes

-Enhanced software protocols

Regulatory Approaches

- Expanding the DOE standard to cover additional dimming ballasts
  - -BLE requirement at full output
- IOU proposal
  - -BLE requirement at 100, 80, and 50% output, standby mode power limit, requirements to minimize flicker
- Design standard
  - -Would require implementation of cathode cut-out
- Annual Energy Use Performance Standard
  - -Aggregates 100, 80, and 50% dimming points with standby power

Regulatory Approaches

Approach	Standard Type	Estimated energy savings for the year 2029 (GWh)	Number of Products that comply out of 32 tested
Expanding DOE standards	Performance	181	9
IOU CASE Report	Performance	214	9
Cathode cut-out design standard	Design	142	8
Annual energy use performance standard	Performance	388	10

Staff Proposal – Scope and Standard

All fluorescent dimming ballasts that dim to 50% or below would be covered under the proposal

Staff proposes the following annual energy use performance standard:

$$Annual\ Energy\ Use_{Ballast} \leq 0.22 \times Full\ Arc\ Power + 18$$

Staff Proposal – Annual Energy Use Calculation

Staff proposes an annual energy use performance standard based on the following equation:

$$Annual\ Energy\ Use = \frac{(P_{100} \times t_{100} + P_{80} \times t_{80} + P_{50} \times t_{50} + P_0 \times t_0)}{1000}$$

Where P_{100}, P_{80}, P_{50} are the input power measured at 100%, 80%, and 50% dimming, and P_0 is the standby power consumption.

T_{100}, T_{80}, and T_{50} are weighted hours of use in each dimming state and T_0 is the time expected in standby mode.

Staff Proposal – Annual Energy Use Calculation

The time constants are provided in a table

Time Variable	Measurements taken			
	P80, P50	P80, no P50	No P80, P50	No P80, No P50
t_{100}	637	876	1592	2388
t_{80}	1592	1890	0	0
t_{50}	955	0	1592	0
t_0	5576	5576	5576	5576

Staff Proposal – Test Method

Staff proposes to use the DOE test procedure for fluorescent ballasts: 10 C.F.R. Section 430.23(q) (Appendix Q1 to Subpart B of part 430)

Staff proposes some modifications

-Describes the measurement of “max arc power”

-Sets specific selection rules for lighting controls

-Includes a methodology for measuring at dimmed states

Staff Proposal – Selection of Controls

The proposed test procedure creates the following preference for lighting controls (from most preferred to least):

-A lighting control from the same manufacturer

-A lighting control recommended by the manufacturer

-A lighting control selected by the lab technician

Further the lighting control with the minimum of additional functionality shall be selected

Staff Proposal – Testing in Dimmed States

Testing at dimmed states is required using similar methodology as used to measure the full output state for fixed ballasts.

The output is tuned based on arc power, and measurements are taken at 80% and 50% of maximum arc power using associated controls.

For dimming ballasts that cannot be tuned to those levels the procedure requires the next closest level within a tolerance. If there is no such level, then that dimming level shall not be measured.

For 80% dimming the range is 65%-90%, for 50% dimming the range is 35%-65%.

Staff Proposal – Testing Standby Mode

The staff proposal adds detail to standby mode testing

Describes the control setting that corresponds with standby mode

Requires a 90 minute waiting period before measuring standby mode

Sets minimum sampling rate and test period to determine the average standby mode power

Staff Proposal – Data Reporting

All dimming ballasts within the scope would be required to report:

- Ballast Voltage
- Number of lamps it can power
- Lamp types it is compatible with
- Dimming type
- Control type
- Start type
- Input power at 100%, 80%, and 50% arc power
- Arc power at 100%, 80%, and 50% arc power
- Calculated annual energy use
- Power factor at full output

Staff Proposal – Costs

Test results of 32 dimming ballasts did not show any correlation between cost and efficiency.

The DOE analyzed the cost of cathode-cutout and improving efficiency in their research on fixed output ballasts. Using that data staff estimates incremental costs to be:

Number of lamps	Incremental Cost
1	$0.79
2	$0.89
3	$0.99
4	$1.09

Staff Proposal – Lifecycle analysis

Number of Lamps	Design Life (years)	Annual Energy Savings (kWh/ yr)	Annual Dollar Savings ($)	Lifetime Dollar Savings ($)
1	13	4.6	$0.67	$8.71
2	13	9.3	$1.36	$17.68
3	13	13.4	$1.96	$25.48
4	13	18.2	$2.66	$34.58

Staff Proposal – Statewide Savings

Number Of Lamps	Average Energy Consumption Baseline (kWh/yr)	Average Energy Consumption Standard (kWh/yr)	Annual Shipments 2016 (Thousand)	One year of shipment savings (GWh/yr)	Savings in the year 2029 (GWh/yr)
1	98.3	95.6	240	0.7	13
2	177.2	171.0	1,233	7.7	146
3	263.3	252.5	407	4.4	83
4	317.3	303.7	558	7.6	146
TOTAL	-	-	2,438	20.4	388

Next Steps

- Consider input from today's workshop and written comments. Written comments are due by June 6, 2014.
- Revise staff report analysis and proposed requirements, as necessary
- Commission staff is available to discuss questions and concerns at any time during the proceeding.

Discussion & Comments

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Docket #14-AAER-1

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